Insights into Fluid Flow Mechanisms in Low Porosity Reservoirs

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Monitoring the dynamics of subsurface fluids has been a major focus of research in geotechnical and geological engineering in the recent years. This phenomenon is particularly noticeable in the analysis of unconventional oil and gas reservoirs, such as low-porosity sandstone, where variations in the fracture length and complicated distribution of pores make the task difficult. In this case, the pore network exhibits a heterogeneous structure that includes both stiff and soft pores, leading to pore-scale creation of heterogeneous porous media. Furthermore, there is a frequent patchy saturation in the fluid distribution inside these rock pores, which is defined by patches that have diameters larger than the wavelength scale; they, however, remain smaller than the individual pores. These changes also affect the heterogeneity of the rock, which causes wave-induced flow in the low- porosity sandstone at the micro- and mesoscopic levels. Recent research challenges the conventional understanding of fluid flow characteristics by demonstrating the possibility of micro-flow in the seismic and acoustic frequency ranges. However, a detailed grasp of the velocity and frequency characteristics at various frequencies is necessary to fully understand these occurrences, particularly in the context of velocity dispersion and attenuation research. Current research highlights the non-uniform characteristics of subsurface porous medium in all forms and sizes, indicating potential connections between wave-induced flow at the meso- and microscale. Soft pores, contrary to stiff ones can dramatically change the saturation modulus. These changes then affect the mesoscopic-scale viscoelastic response of porous media in a wide range of frequencies. Considering these results, developing a fluid flow mechanism that creates velocity correlations over a variety of frequency ranges in low porosity sandstone while accounting for heterogeneities at the pore- and mesoscopic scale is imperative.